Interpretation of the First Data on Central Au+Au Collisions at $\sqrt{s} = 56$ and 130 A GeV *

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The first data from the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory has been presented by the PHOBOS collaboration. Their result is that the numbers of electrically charged hadrons per unit of pseudo-rapidity, $dN_{ch}/d\eta$, produced in the 6% most central Au+Au collisions at $\sqrt{s} =$ 56 and 130 A GeV and averaged over the interval $|\eta| < 1$, are 408±12(stat)±30(syst) and 555±12(stat)±35(syst), respectively.

The previous maximum energy for heavy ion collisions was $\sqrt{s} = 17$ A GeV for Pb+Pb collisions at the SPS at CERN. Particle production in a high energy heavy ion collision is one of the fundamental observables. In a paper published in Physical Review C[1], J.Kapusta and I reported on a comparison of three semi-microscopic theories with both the RHIC and the SPS data in an attempt to understand the basic dynamics of these collisions. These theories are (1) a Linear EXtrapolation of Ultrarelativistic nucleon-nucleon Scattering to nucleus-nucleus collisions (LEXUS), (2) the Wounded Nucleon Model (WNM), and (3) the Collective Tube Model (CTM). Thy are based on input from nucleon-nucleon collisions but are not computed with QCD.

We compare these semi-microscopic theories to the first data on particle production in central Au+Au collisions taken at RHIC by the PHOBOS collaboration as well as to existing data on central Pb+Pb collisions taken at the SPS by the NA49 collaboration. LEXUS represents the SPS data quite well but predicts too many particles at RHIC. The wounded nucleon model predicts too few particles at both the SPS and RHIC; the collective tube model predicts fewer particles still. This suggests a transition in the dynamics of particle production between $\sqrt{s} = 17$ and 56 A GeV as one goes from the SPS to RHIC.

In the following figure we plot the predictions for dN_{ch}/dy from the three theories and the available data. The first panel is for the 5% most central Pb+Pb collisions at the SPS with $\sqrt{s} =$ 17 A GeV. The data from NA49 contains identified electrically charged kaons and pions and is truly the rapidity density. The next three panels are for the 6% most central Au+Au collisions at RHIC with $\sqrt{s} = 56$, 130 and 200 A GeV.

The ordering of the three theories is easily understood. The LEXUS produces more particles than the WNM because in the latter theory a nucleon, once wounded, cannot itself produce any more particles. On the contrary, in the LEXUS a struck nucleon loses momentum but continues to produce particles on every subsequent collision. The CTM produces fewer particles than the WNM as a consequence of the fact that particle production increases more slowly than $\sqrt{s}$.

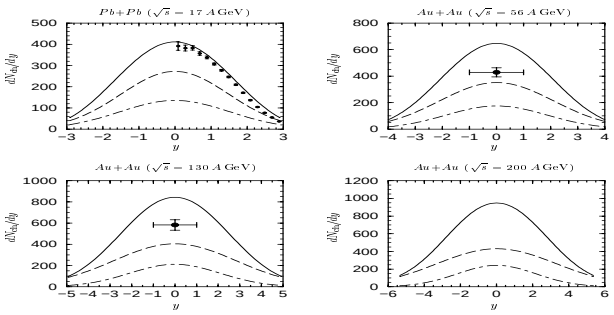

Figure 1: Solid line: LEXUS. Dashed Line: WNM. Dot-Dashed Line: CTM.

Footnotes and References

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[1]Phys. Rev. C63 (2001) 011901